Measurement of evaporation residue cross sections for sub-barrier $^{16}O+^{238}U$ reaction

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Fission fragment angular distributions for heavy-ion reactions using actinide target show anomalously large anisotropy (A=W(180°)/W(90°)) compared to the transition state model. By assuming the quasi-fission being responsible for the large anisotropy, it was concluded [1] in the $^{16}O+^{238}U$ reaction that quasi-fission is dominated and complete fusion is hindered in the sub-barrier energy region, where the interaction of the projectile is restricted to the tip of the prolately deformed target. In order to verify the discussion, we measured the evaporation residue (ER) cross sections for ^{16}O + ^{238}U as the direct evidence of complete fusion. The data was taken from $E_{c.m.}$= 100 MeV down to 72 MeV corresponding to 0.88 times the average Coulomb barrier (81.4 MeV).

The ^{16}O beams were supplied by the JAERI-tandem accelerator and bombarded the natural ^{238}U target. The ERs recoiling out of the target were transported by a He-gas loaded with KCl aerosol clusters through a capillary and deposited at a periphery of a 80-cm-diameter wheel. The wheel was rotated every 150 s to collect a new deposit and to detect α decays by a series of 18 silicon detectors in order to determine the production rate.

The α decays of $^{250,249,248}Fm$ were clearly observed and the corresponding cross sections were determined. The cross sections were compared to a statistical model calculation. In the calculation, the fusion cross section was determined by a coupled channel code [2], which takes into account the static deformation of the target and reproduces the experimental fission cross sections for ^{16}O + ^{238}U. At and above the Coulom barrier, the calculation nicely reproduced the experimental data. Also in the sub-barrier region, the experimental data agrees with the calculation and the fusion hindrance was not observed. We obtained a conclusion that complete fusion occurs in the sub-barrier region and the quasi-fission is not the reason for the anomalously large fission anisotropy.

References

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